# CLAIMS

1. A mixing apparatus for use with a vessel having a contiguous sidewall centered about and defining a longitudinal axis, the mixing apparatus comprising:

a mixing head having a tubular blade portion centered about and defining a head axis and having a first tube end and a second tube end spaced apart from one another therealong, the blade portion tapering from the first tube end to the second tube end with the inner surface of the blade portion and the second end defining an inside blade diameter "ID" and the outer surface of the blade portion and the first end defining an outer blade diameter "OD";

mounting means for mounting the mixing head substantially coaxial to and within the vessel for longitudinal movement relative thereto; and

reciprocating means for effecting said longitudinal relative movement of the mixing head in a reciprocating manner through a stroke length "S", with a duration "T" for each cycle,

wherein $175 \lesssim 0.36 \times OD^2/ID^2 \times S/T \lesssim 250$

when OD, ID and S are each expressed in inches, and T is expressed in minutes.

2. A mixing apparatus according to claim 1, wherein the blade portion tapers in a substantially frustoconical manner from the first tube end to the second tube end.

3. A mixing apparatus according to claim 2, wherein

a pair of axes are defined by and coincident with the intersections of the outer surface of the blade portion and a plane coincident with the head axis; and

$90 \text{ degrees} \lesssim \alpha \lesssim 180$ degrees, wherein angle $\alpha$ is defined by the angle between said pair of axes.

4. A mixing apparatus according to claim 1, wherein the mounting means comprises a mixer shaft, the mixer shaft having a bottom end operatively rigidly connected to the mixing head and extending from said bottom end, substantially parallel to the head axis, to a top end which is disposed above the vessel in use.

5. A mixing apparatus according to claim 4, wherein the reciprocating means comprises shaft gripping means for gripping the mixer shaft adjacent the top end for effecting longitudinal reciprocating movement of the shaft gripping means through stroke length "S" with duration "T" for each cycle, thereby to effect said longitudinal movement of the mixing head in said reciprocating manner.

6. A mixing apparatus according to claim 5, further comprising a housing positionable above said vessel.

7. A mixing apparatus according to claim 6, wherein the reciprocating means comprises:

a flywheel mounted to the housing for rotation about a rotational axis which is normal to the longitudinal axis;

a crank member projecting from the flywheel in a direction parallel to the rotational axis and connected to the flywheel for rotation therewith; and

a yoke displaced from the flywheel in the direction of the crank member and having a substantially linear race formed therein which is in receipt of the crank member and is adapted to permit relative translational movement of the crank member and the yoke, wherein the yoke is positioned with the race arranged normal to the rotation axis and bisected thereby and is mounted to the housing in a manner which constrains movement of the yoke therefrom otherwise than along an axis parallel to the longitudinal axis and normal to the rotational axis such that, during rotation of the flywheel, the crank member imparts longitudinal reciprocating movement to the yoke, and wherein the shaft gripping means is operatively rigidly connected to the yoke for longitudinal reciprocating movement therewith.

8. A mixing apparatus according to claim 7, wherein the reciprocating means includes a drive means for driving said rotation of the flywheel.

9. A mixing apparatus according to claim 8, wherein the drive means is an electric motor.

10. A mixing apparatus according to claim 4, wherein the mixer shaft extends from the mixing head substantially coincident with the head axis.

11. A mixing apparatus according to claim 10, wherein the bottom end of the mixer shaft is operatively rigidly connected to the mixing head by a hub member rigidly connected to the bottom end of the mixer shaft and a plurality of support webs extending between and connecting the hub member and the blade portion.

12. A mixing apparatus according to claim 11, wherein the support webs are formed with a plurality of perforations extending therethrough, and with a plurality of tabs, each tab substantially overlying a respective one of the plurality of perforations and being connected to the support web at one edge of said respective one of the plurality of perforations to form a gill.

13. A mixing apparatus according to claim 1, wherein the blade portion has a plurality of dimples projecting outwardly from the outer surface.

14. A mixing apparatus according to claim 1, wherein the blade portion has a plurality of dimples projecting inwardly from the inner surface.

15. A mixing apparatus according to claim 1, wherein the blade portion has a plurality of perforations each extending between the inner surface and the outer surface.

16. A mixing apparatus according to claim 1, wherein the mounting means is adapted to mount the mixing head within the vessel with the first tube end disposed below the second tube end.

17. A mixing apparatus according to claim 1, wherein the mounting means is adapted to mount the mixing head within the vessel with the first tube end disposed above the second tube end.

18. Use of the mixing apparatus of claim 1 as a mixer for a vessel in an SXEW extractor unit, the vessel having an internal diameter D and a height H.

19. Use according to claim 17, wherein OD:D is between about 1:2.5 to 1:4 and ID:OD is between about 1:0 to 1.5.

20. Use according to claim 18, wherein D:H is approximately 1:1.

21. Use of the mixing apparatus of claim 1 as a mixer for the vessel in a froth flotation cell.

22. A mixing apparatus according to claim 6, wherein the mounting means further comprises a linear bearing assembly supporting the mixer shaft, in use, for longitudinal movement, the linear bearing assembly so supporting the mixer shaft at a first location, relatively proximal to the shaft gripping means, and at a second location, disposed downwardly from the first location and relatively distal to the shaft gripping means.

23. A mixing apparatus according to claim 22, wherein the linear bearing assembly includes a first portion securely attached to the housing and disposed to one side of the mixer shaft in use and a second portion, disposed to the other side of the mixer shaft in use and operatively removably secured to the housing to permit, when removed, removal and replacement of the mixer shaft.

24. A mixing apparatus according to claim 22, wherein the linear bearing assembly includes a bushing to provide for said support of the mixer shaft at the first location, the bushing being formed of mating bushing blocks which form, respectively, part of the first portion and the second portion of the linear bearing assembly.

25. A mixing apparatus according to claim 24, wherein the linear bearing assembly includes a plurality of rollers arranged to circumferentially surround said mixer shaft in use and thereby to provide for said support of the mixer shaft at the second location, the plurality of rollers being formed of mating roller subassemblies which form, respectively, part of the first portion and the second portion of the linear bearing assembly.

26. A mixing apparatus according to claim 25, wherein the roller subassembly which forms part of the first portion comprises a pair of rollers, and wherein the roller subassembly which forms part of the second portion comprises one roller.